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A SURVEY OF THE PRESSURE DISTRIBUTION WITHIN THE PLENUM CHAMBER OF THE XR-3 TESTCRAFT

Rodman Michael Eddy

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THESIS

A SURVEY OF THE PRESSURE DISTRIBUTION WITHIN
THE PLENUM CHAMBER OF THE XR-3 TESTCRAFT

by

Rodman Michael Eddy

September 1975

Thesis Advisor: Donald M. Layton

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A pressure survey of the cavity (plenum chamber) was conducted on the XR-3 Surface Effect Ship (SES) Testcraft. The lowest pressures were observed at 15 knots, and the highest pressures at 21 knots. Pressure variations with velocity were observed to be similar in all cases, with a pressure decrease from 1[illegible] to 15 knots, an increase from 15 to 21 knots, a fluctuation and slight decrease from [illegible] to [illegible] knots, and [illegible] [illegible]ease from [illegible]

20.

26.5 knots. All pressures have been plotted to show graphically the pressure variation versus velocity and position within the plenum chamber from bow seal to stern seal, and from port side to starboard side. The shape and gradient of pressures was observed to vary directly with velocity.

A Survey of the Pressure Distribution within the Plenum Chamber of the XR-3 Testcraft

by

Rodman Michael Eddy
Lieutenant Commander, United States Navy
B.S., United States Naval Academy, 1964

Submitted in partial fulfillment of the
requirements for the degree of

MASTER OF SCIENCE IN AERONAUTICAL ENGINEERING

from the

NAVAL POSTGRADUATE SCHOOL
September 1975

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ABSTRACT

A pressure survey of the cavity (plenum chamber) was conducted on the XR-3 Surface Effect Ship (SES) Testcraft. The lowest pressures were observed at 15 knots, and the highest pressures at 21 knots. Pressure variations with velocity were observed to be similar in all cases, with a pressure decrease from 12 to 15 knots, an increase from 15 to 21 knots, a fluctuation and slight decrease from 21 to 24 knots, and a decrease from 24 to 26.5 knots. All pressures have been plotted to show graphically the pressure variation versus velocity and position within the plenum chamber from bow seal to stern seal, and from port side to starboard side. The shape and gradient of pressures was observed to vary directly with velocity.

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I. INTRODUCTION

The XR-3 Surface Effect Ship (SES) Testcraft, shown in Figure (1), has been utilized for extensive performance testing since its construction in 1965, and subsequent transfer to the Naval Postgraduate School in March, 1970. Tests conducted have included lift and drag relationships, velocity and drag relationships, and a previous evaluation of plenum chamber pressures. (Ref. 1)

In March, 1973, a modification was completed on the XR-3 (Ref. 2). A fourteen channel tape recorder and its associated equipment were installed, and the craft's seals were improved. The seal modification involved a removal of the original seals and a replacement with flexible, air-filled seals. Previous tests had shown that the more flexible seals would allow a more constant maintenance of contact with the water, and as a result, steadier pressure within the plenum chamber. The plenum chamber pressure could also be varied and maintained with fewer blowers than with the original design. The single aft blower is used to pressurize the aft seal, two blowers pressurize the forward seal, and the remaining two deliver air directly to the cavity (plenum chamber) under the craft.

Performance testing since the time of installation of the new seals and of the automatic data-recording equipment has been to determine optimum seal position as well as to re-evaluate previously measured lift and drag parameters.

The amount of pressure within the seals has been varied and the effect on performance recorded. Future testing is planned to evaluate the dynamic forces acting on the seals and transmitted to the hull.

In March, 1975, instrumentation and pressure-measuring equipment was installed to permit recording of the pressures within the plenum chamber. Once a total pressure survey had been completed, it was hoped to determine the effect of velocity on the measured pressures, if any, as well as to present graphically the relationship of velocity versus pressure and location. Pressure measurements were taken from the port sidewall to the centerline and from just aft of the bow seal to just forward of the stern seal.

All testing has been performed at Lake San Antonio, 100 miles south of Monterey, California.

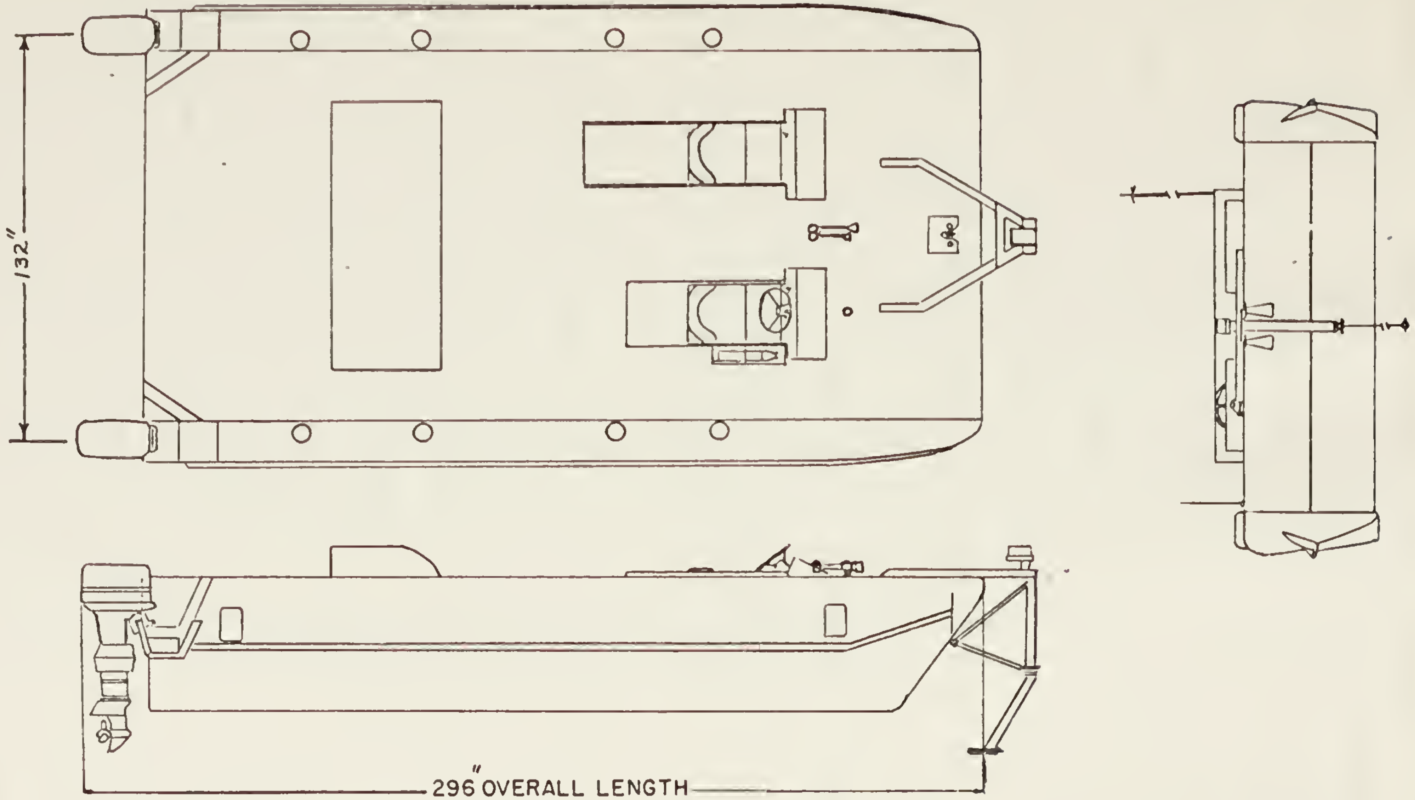

FIGURE (1)
XR-3 SCHEMATIC

II. NATURE OF THE PROBLEM

The XR-3 is a blunt-nosed vessel having a length of 24 feet, a beam of 12 feet, and weighing approximately 5350 pounds. It utilizes five small four-cycle gasoline engines to drive five lift fans. Air from the fans is ducted to both the bow and stern seals and to the plenum chamber. Through use of the ducting the bow and stern seals are pressurized and thus forced to ride on the surface of the water. Two forty-horsepower outboard motors are used to provide propulsive power. One motor has been reworked to allow the propellor to rotate in a direction counter to the rotation of the propellor of the opposite motor in order to minimize the thrust vector variations and to reduce cavitation.

For typical test runs, the data-recording equipment was installed and calibrated, the fan motors were started, the fans engaged, and pressure was supplied to the bow seal, stern seal, and the plenum chamber. Once this operation had been completed satisfactorily, the trailer was placed in the water, and the XR-3 allowed to float off. At this time the outboard motors were started and allowed to warm to operating temperature. While on the cushion, the XR-3 has an exterior draft of from 6 to 10 inches, and an interior draft of 1 to 2 inches. If the pressure in the plenum chamber were to be lost once the craft is in the water, water could enter the tubing used for pressure measurement, although the

XR-3 would experience no difficulty. Once under power the XR-3 was accelerated slowly, and at 3 to 4 knots a wave formed in front of the stern seal. A bow wave formed ahead of the bow seal at approximately 6 to 7 knots. At about half throttle this bow wave was overridden, and the craft was observed to accelerate rapidly. This transition occurred at approximately 11 knots and was accomplished by a large reduction in drag and the power required for operation.

Pressures within the plenum chamber were evaluated in the range of 12 to 26.5 knots. In this speed range, the XR-3 is supported by the aerostatic lift from the fans, hydrostatic lift on the sidewalls, and hydrodynamic lift generated by the sidewalls and seals due to the forward velocity. Pressure variations with velocity and position within the plenum chamber are representative of the operating range of the XR-3.

III. EXPERIMENTAL PROCEDURE

Pressures within the plenum chamber of the XR-3 were measured through the use of 1/8-inch inside diameter plastic tubing, two electrically operated selector boxes, two manually controlled, electrically operated scanner valves, a pressure transducer, a signal amplifier, and the automatic data-recording equipment. Figure (2) is a general outline of the plenum chamber and seal position. Figure (3) shows the experimental apparatus used. Figure (4) shows the area of the plenum chamber used for pressure tap locations during the various test runs. Calibration of the pressure-measuring equipment was accomplished by use of a U-tube water manometer, and the amplifier output was set to allow a pressure of 50 pounds per square foot (PSF) to be represented by 1.000 volts D.C., i.e., 1 millivolt equalling 0.05 PSF.

Once the reliability of the pressure-measuring equipment had been ascertained and XR-3 familiarization runs had been completed, a series of test runs was performed in order to collect pressure data. All test runs were made with the pressure pick-up points located in three fore-and-aft rows, from the port sidewall to the centerline, and from just aft of the forward seal to a location 40 inches aft of the bow seal. Pressure pickups were located on one side of the craft because previous tests had indicated that the pressure distribution was symmetrical. Initial pick-up

locations next to the port sidewall ("A" Row) started eight inches aft of the bow seal and continued at eight-inch intervals to 40 inches aft. Pick-up locations halfway between the port sidewall and centerline of the XR-3 ("B" Row) started four inches aft of the bow seal, and continued at four-inch intervals to 40 inches aft. Pickup locations on the centerline of XR-3 ("C" Row) started eight inches aft of the bow seal, and continued at eight-inch intervals to 40 inches aft. The XR-3 was accelerated to 12 knots and allowed to stabilize. Once stabilized, the series of pressure readings was taken by operating the selector boxes controlling the scanner valves. As each position was selected, a time interval of 30 to 45 seconds was allowed to elapse in order to minimize any transient pressures, and a voice recording would state which pressure tap was currently being measured. The pressures summarized and plotted were those observed for each station at the end of the time interval and the simultaneous voice recording on the tape. Pressure measurement was continuous; manual control of the selectors and observation of the specified time interval allowed a reliable pressure survey. The test runs were repeated for velocities of 15, 18, 21, 24 and 26.5 knots.

The second series of runs followed an identical format, with the "A", "B", and "C" rows staying at the same lateral position as described previously. The distance aft of the bow seal did change, however. Each row started at 16 inches aft and continued to 160 inches aft; the number and

spacing were identical: 5 pick-up points located at 16 inches, 60 inches, 100 inches, 148 inches, and 160 inches. Data were taken in a manner similar to that described for the forward section of the plenum chamber.

On the third series of runs, pressure data were taken of the aft section of the plenum chamber, forward of the aft seal. The "A", "B", and "C" row location remained the same. Five pressure pickups were positioned in the "A" and "C" rows (port sidewall and XR-3 centerline) located from 124 inches aft of the bow seal to 156 inches aft, at intervals of eight inches. The "B" row (halfway between the port sidewall and XR-3 centerline) contained 10 pressure pickups and extended from 124 inches aft of the bow seal to 160 inches aft at intervals of four inches. The test velocities and stabilization time between pressure readings were identical to those used during the first and second series of tests.

Three or four runs were made at each velocity and each pickup setting and the results averaged.

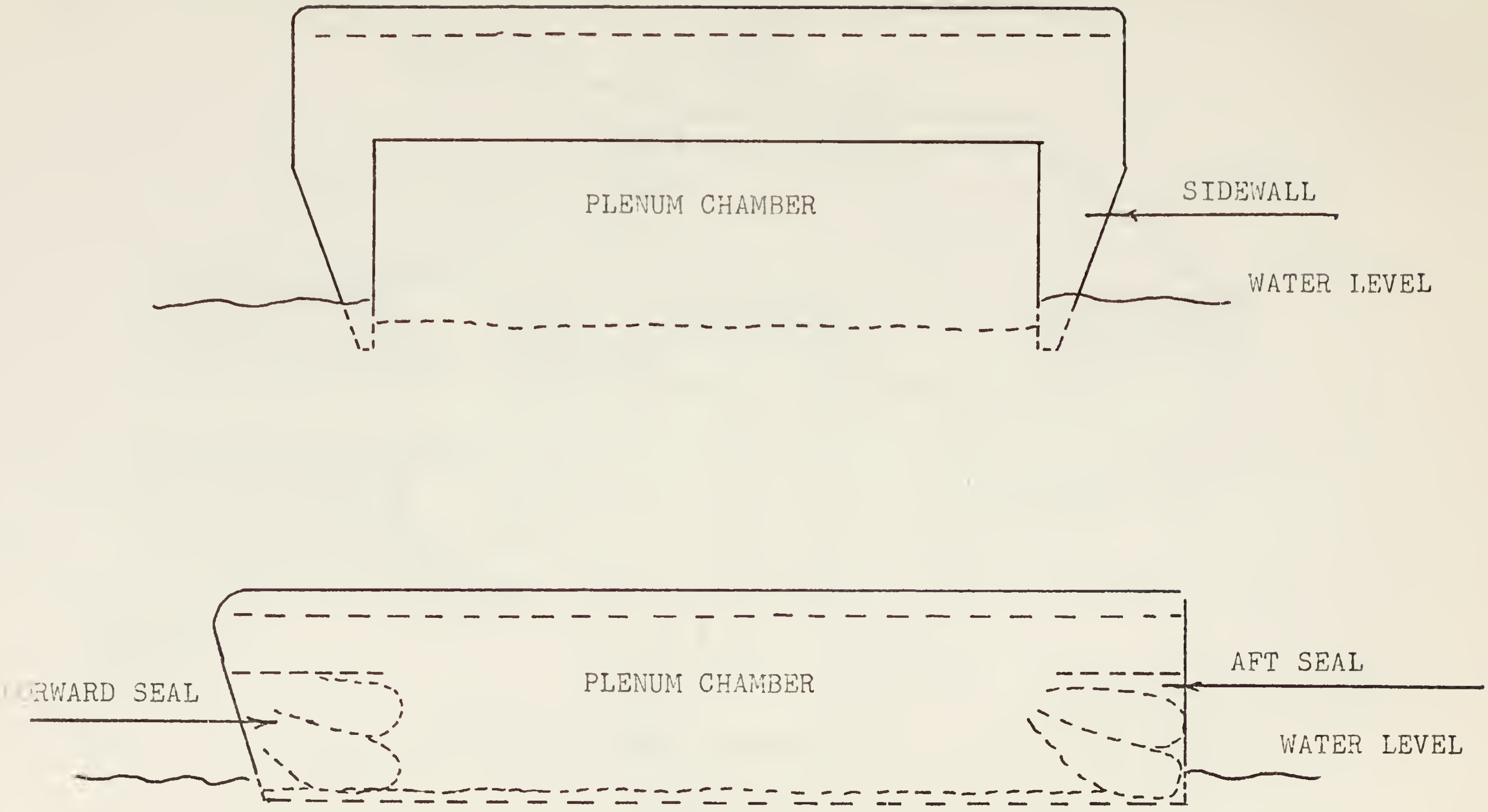

FIGURE (2)

PLENUM CHAMBER OUTLINE

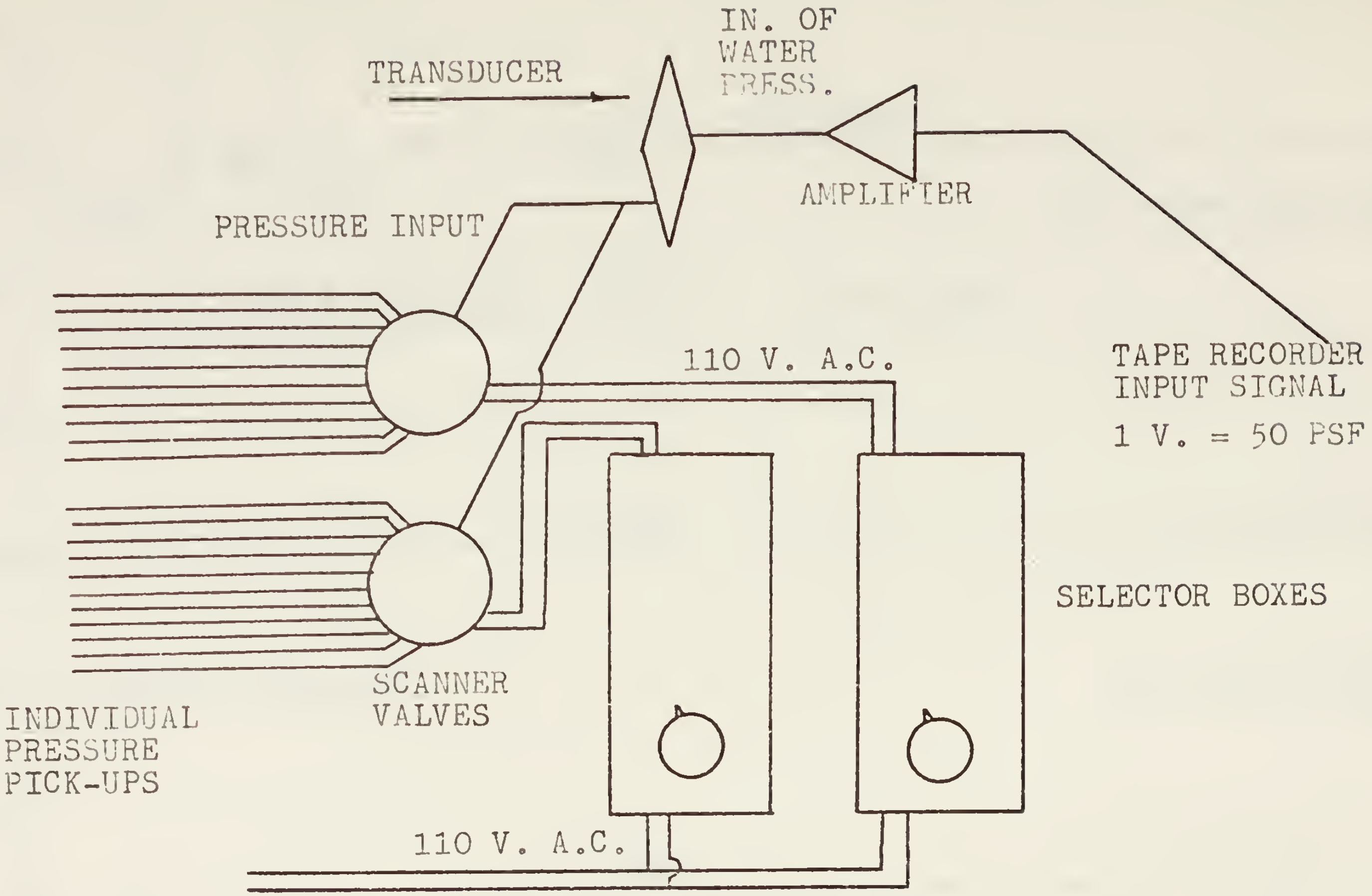

FIGURE (3)
EXPERIMENTAL APPARATUS

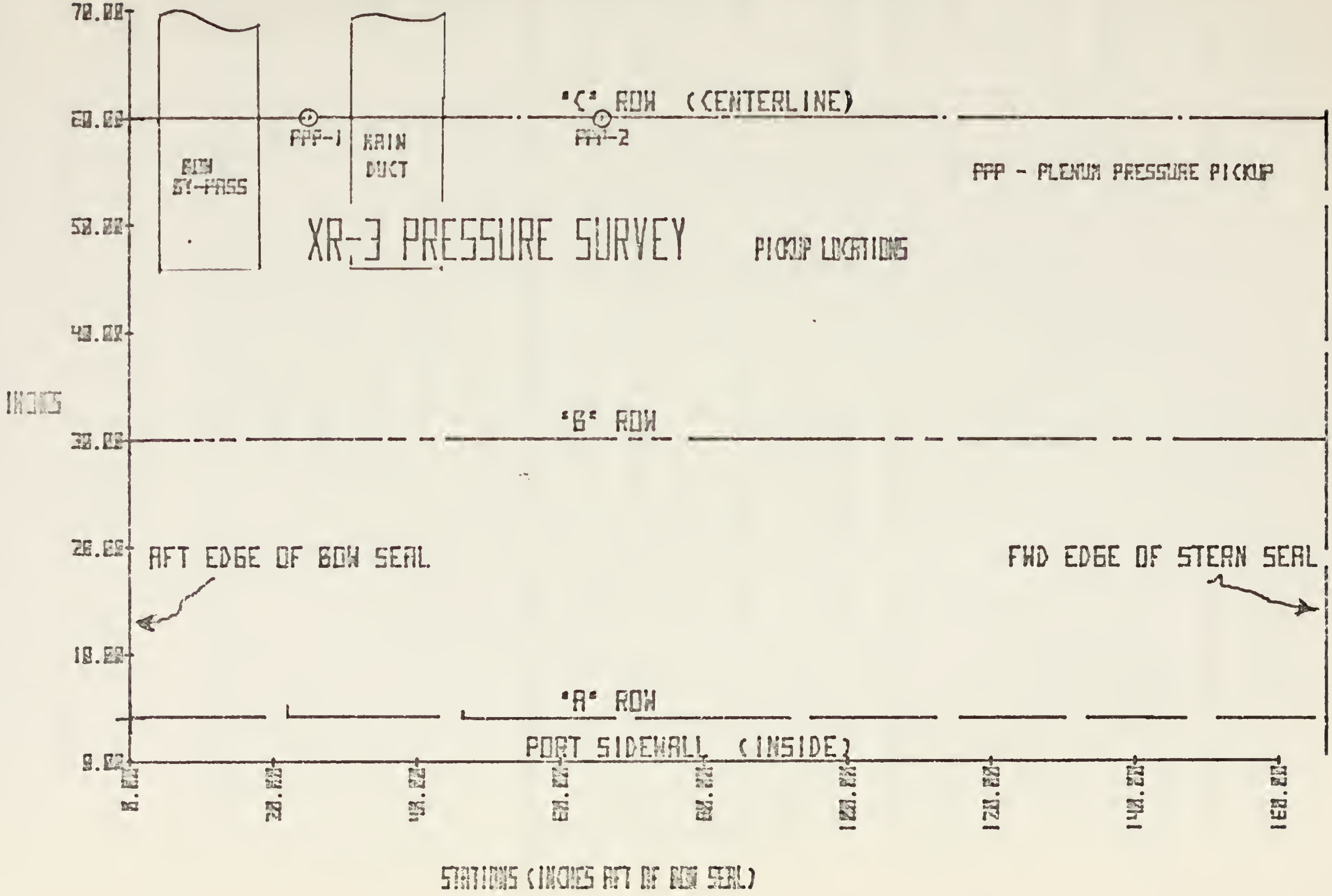
XR-3 PRESSURE SURVEY
PICKUP LOCATIONS
"C" ROW (CENTERLINE)
"B" ROW
"A" ROW
PORT SIDEWALL (INSIDE)
PPP - PLENUM PRESSURE PICKUP
PPP-1
PPP-2
BOW BY-PASS
MAIN DUCT
AFT EDGE OF BOW SEAL
FWD EDGE OF STERN SEAL
INCHES
70.00
60.00
50.00
40.00
30.00
20.00
10.00
0.00
0.00
20.00
40.00
60.00
80.00
100.00
120.00
140.00
160.00
STATIONS (INCHES AFT OF BOW SEAL)

FIGURE (4)

IV. PRESENTATION OF DATA

Pressure data gathered during the series of test runs have been tabulated as well as plotted graphically. The tables are arranged as follows: Table I is a summary of the pressures observed in the forward section of XR-3 at the stated test velocities and pressure tap locations. The three sections (Rows "A", "B", and "C") of the table are plotted as Figures 5, 6, and 7, respectively. Table II is a summary of the pressures observed in the full length of the plenum chamber of XR-3. The three sections (Rows "A", "B", and "C") are plotted as Figures 8, 9, and 10, respectively. Table III is a summary of the pressures observed in the aft section of XR-3. The three sections (Rows "A", "B", and "C") are plotted as Figures 11, 12, and 13, respectively. Figures 14, 15, 16, 17, 18, and 19 are graphical presentations of the pressures observed throughout the full length of XR-3. Only the pressures on the port side of XR-3 were observed. Pressures on the starboard section are assumed to be identical. Each graph is plotted at one test velocity only, and allows an analysis of the pressure variation and shape of the air cushion at that test velocity. Figure 14 corresponds to 12 knots, Figure 15 to 15 knots, etc.

The pressure survey of the forward section shows the lowest pressures to exist at 15 knots, and the highest pressures at 21 knots. An exception exists in the "B" row

(halfway between the port sidewall and the centerline) in that the highest pressure is recorded at 26.5 knots. This row also shows the greatest pressure fluctuation with distance aft of the bow seal. The pressure variation with velocity is the same for all rows: a decrease from 12 to 15 knots, an increase from 15 to 21 knots, a slight decrease (fluctuation in the case of the "B" row) from 21 to 24 knots, and a decrease from 24 to 26.5 knots.

The pressure survey of the full length of the plenum chamber shows the same variation of pressure with velocity, and the "A" row (port sidewall) shows a pressure drop and fluctuation just forward of the stern seal.

The pressure survey of the aft section of the plenum chamber shows essentially the same traits and variations as that of the forward section. There is no evident decrease in pressure at the sidewall or centerline in the area of the seal, but there is a drop in pressure in the area just forward of the aft seal, halfway between the port sidewall and the centerline.

TABLE I

"A" Row Pressures (lb/ft^2)
Forward Section (0-40 inches)

Distance Aft, in.	Velocity, Kts 12	15	18	21	24	26.5
8.00	25.16	24.60	25.01	25.75	25.58	25.50
16.00	25.18	24.62	25.00	25.76	25.61	25.51
24.00	25.20	24.62	25.01	25.78	25.62	25.56
32.00	25.21	24.63	25.01	25.79	25.63	25.59
40.00	25.23	24.65	25.01	25.81	25.63	25.61

"B" Row Pressures (lb/ft^2)
Forward Section (0-40 inches)

Distance Aft, in.	Velocity, Kts 12	15	18	21	24	26.5
4.00	23.83	22.95	23.00	23.17	24.80	25.10
8.00	25.19	23.54	24.02	24.90	25.98	26.17
12.00	25.27	25.20	25.10	25.98	25.98	26.17
16.00	25.39	24.80	25.11	25.92	25.78	25.68
20.00	25.10	24.80	25.05	25.78	26.07	25.68
24.00	24.92	24.61	25.02	25.14	25.97	25.59
28.00	25.29	24.80	25.12	25.98	25.98	25.78
32.00	25.20	24.82	25.01	25.98	25.59	25.59
36.00	25.00	23.63	23.[illegible]9	24.50	24.78	24.90
40.00	25.51	24.44	24.61	25.51	25.97	26.17

"C" Row Pressures (lb/ft^2)
Forward Section (0-40 inches)

Distance Aft, in.	Velocity, Kts 12	15	18	21	24	26.5
8.00	25.57	24.49	25.27	26.12	25.95	25.81
16.00	25.58	24.98	25.29	26.13	25.96	25.82
24.00	25.58	24.99	25.30	26.16	25.97	25.83
32.00	25.60	25.01	25.31	26.20	25.98	25.86
40.00	25.60	25.05	25.31	26.25	25.97	25.90

TABLE II

"A" Row Pressures (lb/ft^2)
Full Length (0-160 inches)

Distance Aft, in.	Velocity, Kts					
	12	15	18	21	24	26.5
16.00	25.18	24.62	25.00	25.76	25.61	25.51
60.00	25.27	24.71	25.03	25.97	25.67	25.53
100.00	25.32	24.93	25.12	26.23	25.81	25.67
148.00	25.44	25.02	25.31	26.38	25.97	26.05
160.00	25.00	24.04	24.75	24.94	25.36	25.81

"B" Row Pressures (lb/ft^2)
Full Length (0-160 inches)

Distance Aft, in.	Velocity, Kts					
	12	15	18	21	24	26.5
16.00	25.39	24.81	25.11	25.92	25.78	25.68
60.00	25.42	24.90	25.23	26.21	25.82	25.71
100.00	25.51	25.13	25.32	26.42	25.97	25.83
148.00	25.61	25.21	25.54	26.55	26.15	26.24
160.00	25.16	24.23	24.91	25.13	25.53	25.97

"C" Row Pressures (lb/ft^2)
Full Length (0-160 inches)

Distance Aft, in.	Velocity, Kts					
	12	15	18	21	24	26.5
16.00	25.58	24.98	25.29	26.13	25.96	25.82
60.00	25.64	25.13	25.37	26.38	25.99	25.97
100.00	25.70	25.31	25.50	26.59	26.12	26.00
148.00	25.79	25.44	25.71	26.73	26.31	26.44
160.00	25.32	24.48	25.13	25.35	25.71	26.18

TABLE III

"A" Row Pressures (lb/ft^2)
Aft Section (120-160 inches)

Distance Aft, in.	Velocity, Kts 12	15	18	21	24	26.5
124.00	25.38	24.98	25.22	26.00	25.88	25.88
132.00	25.39	24.98	25.26	26.32	25.91	25.93
140.00	25.41	25.00	25.29	26.35	25.94	25.98
148.00	25.44	25.02	25.32	26.37	25.98	26.04
156.00	25.46	25.02	25.33	26.39	25.97	26.05

"B" Row Pressures (lb/ft^2)
Aft Section (120-160 inches)

Distance Aft, in.	Velocity, Kts 12	15	18	21	24	26.5
124.00	25.57	25.18	25.34	26.47	26.02	25.97
128.00	25.59	25.17	25.36	26.48	26.04	26.01
132.00	25.58	25.18	25.39	26.49	26.07	26.03
136.00	25.58	25.19	25.42	26.51	26.10	26.05
140.00	25.29	25.20	25.46	26.32	26.11	26.04
144.00	25.59	25.20	25.48	26.54	26.12	26.13
148.00	25.61	25.22	25.53	26.57	26.16	26.20
152.00	25.60	25.21	25.53	26.56	26.16	26.20
156.00	25.59	25.22	25.52	26.57	26.15	26.21
160.00	25.17	24.23	24.92	25.14	25.52	25.97

"C" Row Pressures (lb/ft^2)
Aft Section (120-160 inches)

Distance Aft, in.	Velocity, Kts 12	15	18	21	24	26.5
124.00	25.75	25.38	25.65	26.61	26.23	26.20
132.00	25.75	25.39	25.68	26.64	26.25	26.25
140.00	25.78	25.41	25.68	26.70	26.29	26.34
148.00	25.79	25.43	25.70	26.75	26.32	26.46
156.00	25.80	25.45	25.72	26.70	26.34	26.51

V. CONCLUSIONS

The low pressures observed at 15 knots are related to the transition of XR-3 to its range of cruise speeds. There is an evident escape of air at this velocity, caused as the craft overrides the bow wave completely. The highest pressures observed at 21 knots are felt indicative of XR-3's optimum cruise velocity, and correspond to minimum pressure loss. The pressure drop at 26.5 knots would logically be caused by pumping due to the rapid water flow through the plenum area and by seal oscillations allowing a high cyclic venting of pressure. This was especially observed in the "B" row (halfway between port sidewall and centerline). The port sidewall area has pressures approximating the average pressure of the plenum chamber, as does the center section of the aft seal. This is thought to be caused by a better contact of the center section of the seal with the water. The area of the plenum chamber just aft of the forward seal is observed to lose a slight amount of pressure across the width of the plenum. This is thought to be caused by cyclic motion of the seal as it traverses the typical small waves of the lake, as well as by a venting at each side due to incomplete contact with the sidewalls.

A. SUMMARY OF CONCLUSIONS

1. The highest pressures were observed at 21 knots, and the lowest pressures at 15 knots, with the exception of the area between the port sidewall and the centerline. In this area, pressures were a maximum at 26.5 knots.

2. Pressure variation with velocity was the same in all cases: a drop from 12 to 15 knots, an increase from 15 to 21 knots, and a decrease from 21 to 26.5 knots.

3. The area of the plenum chamber just aft of the forward seal is observed to lose a slight amount of pressure throughout, most likely caused by venting between the seal and the sidewalls.

4. The area of the plenum chamber just forward of the aft seal exhibits a pressure drop between the port sidewall and centerline. The sidewall maintains the plenum pressure, as does seal contact and water flow at the centerline.

5. The random variations of the forward section, "B" row (halfway between port sidewall and centerline), are indicative of a water and air pressure interaction of some sort. It is felt at this time to be due to the existence of a wave within the plenum chamber, formed through a combination of air pressure and velocity when the XR-3 is underway.

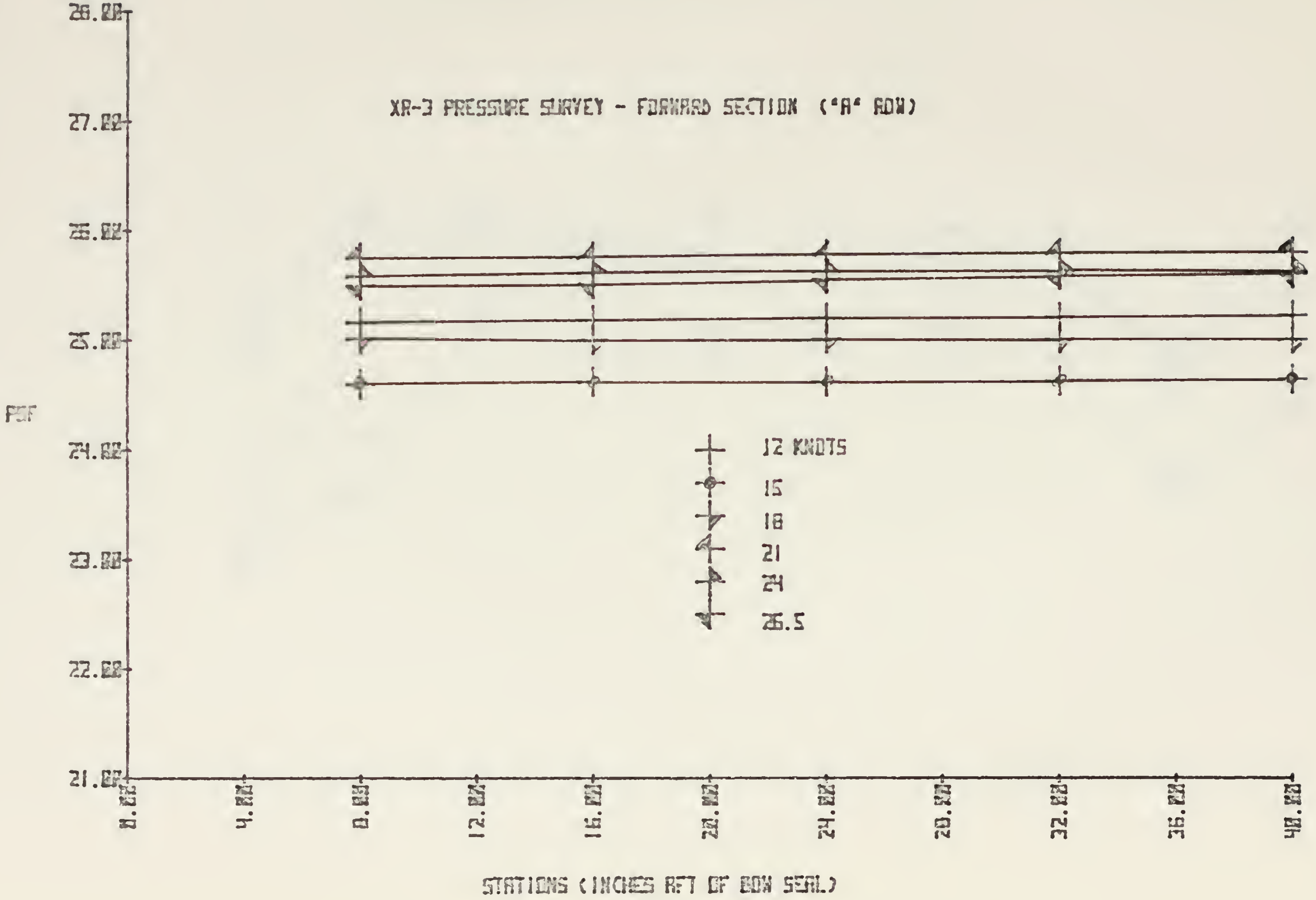
XR-3 PRESSURE SURVEY - FORWARD SECTION ('A' ROW)
28.00
27.00
26.00
25.00
24.00
23.00
22.00
21.00
PSF
0.00
4.00
8.00
12.00
16.00
20.00
24.00
28.00
32.00
36.00
40.00
STATIONS (INCHES AFT OF BOW SEAL)
12 KNOTS
15
18
21
24
26.5

FIGURE (5)

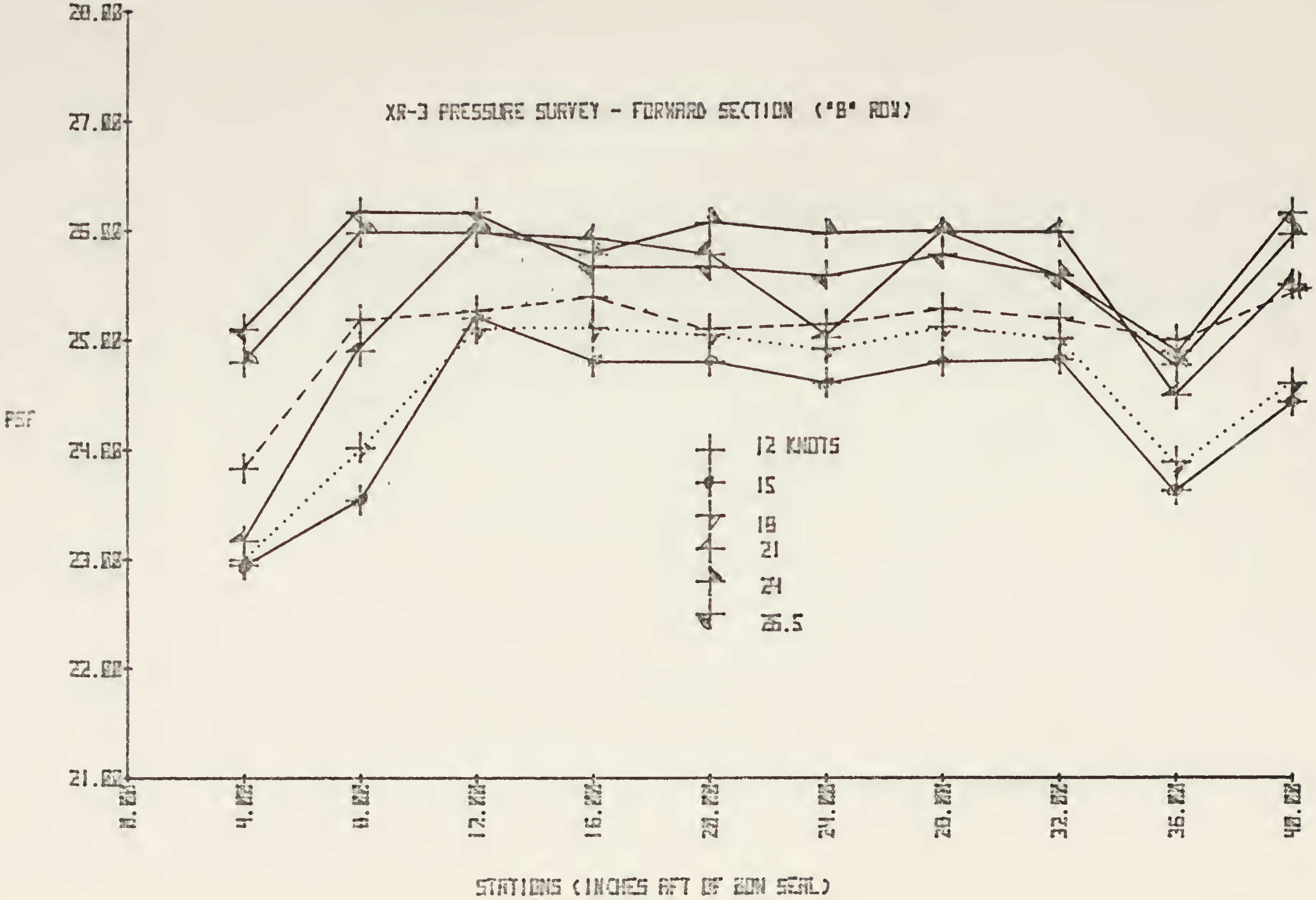
XR-3 PRESSURE SURVEY - FORWARD SECTION ("B" ROW)
PSF
28.00
27.00
26.00
25.00
24.00
23.00
22.00
21.00
0.00
4.00
8.00
12.00
16.00
20.00
24.00
28.00
32.00
36.00
40.00
STATIONS (INCHES AFT OF BOW SEAL)
12 KNOTS
15
18
21
24
26.5

FIGURE (6)

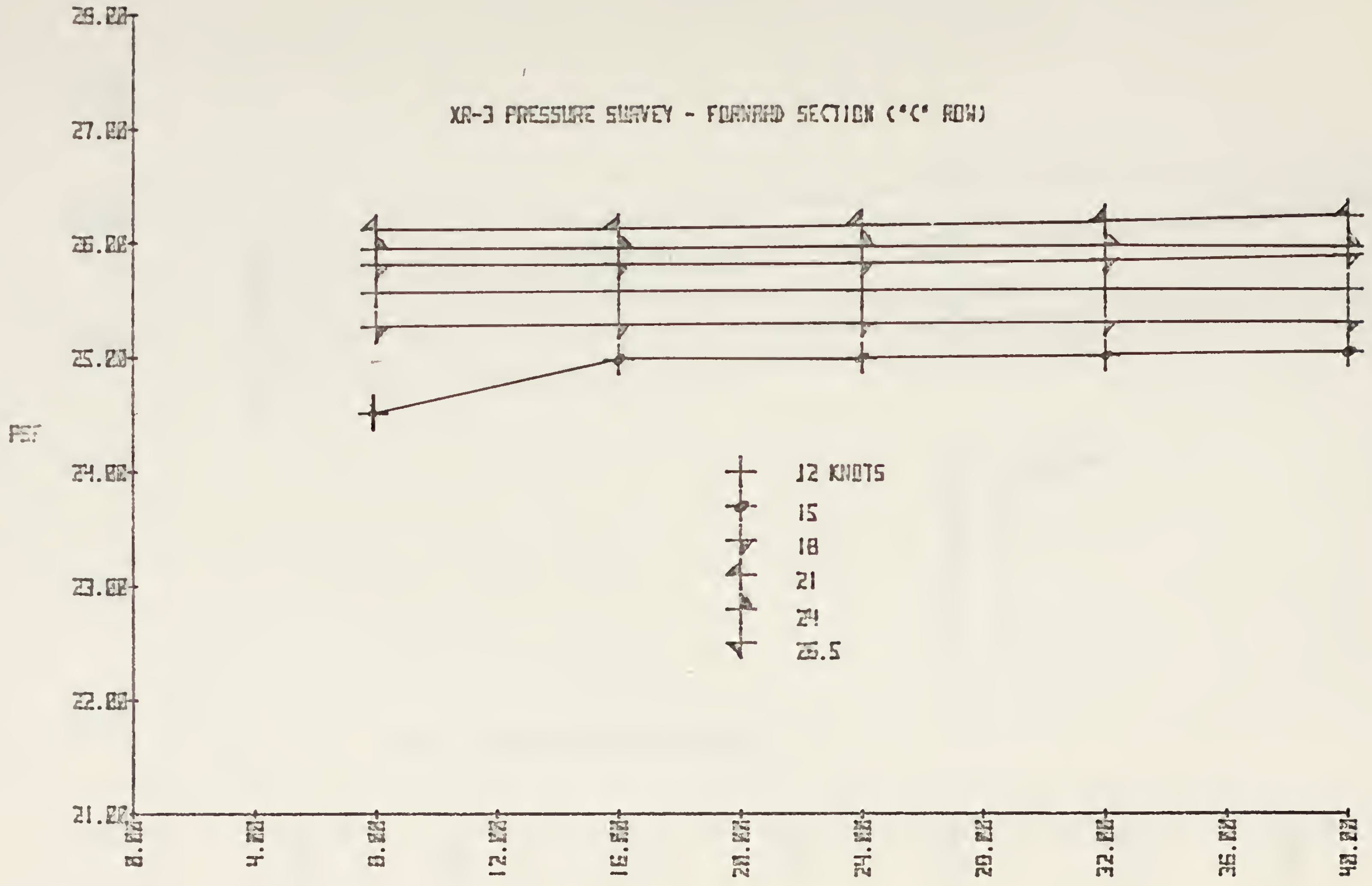
XR-3 PRESSURE SURVEY - FORWARD SECTION ("C" ROW)
PSF
28.00
27.00
26.00
25.00
24.00
23.00
22.00
21.00
0.00
4.00
8.00
12.00
16.00
20.00
24.00
28.00
32.00
36.00
40.00
12 KNOTS
15
18
21
24
26.5
STATIONS (INCHES AFT OF BOW SEAL)

FIGURE (7)

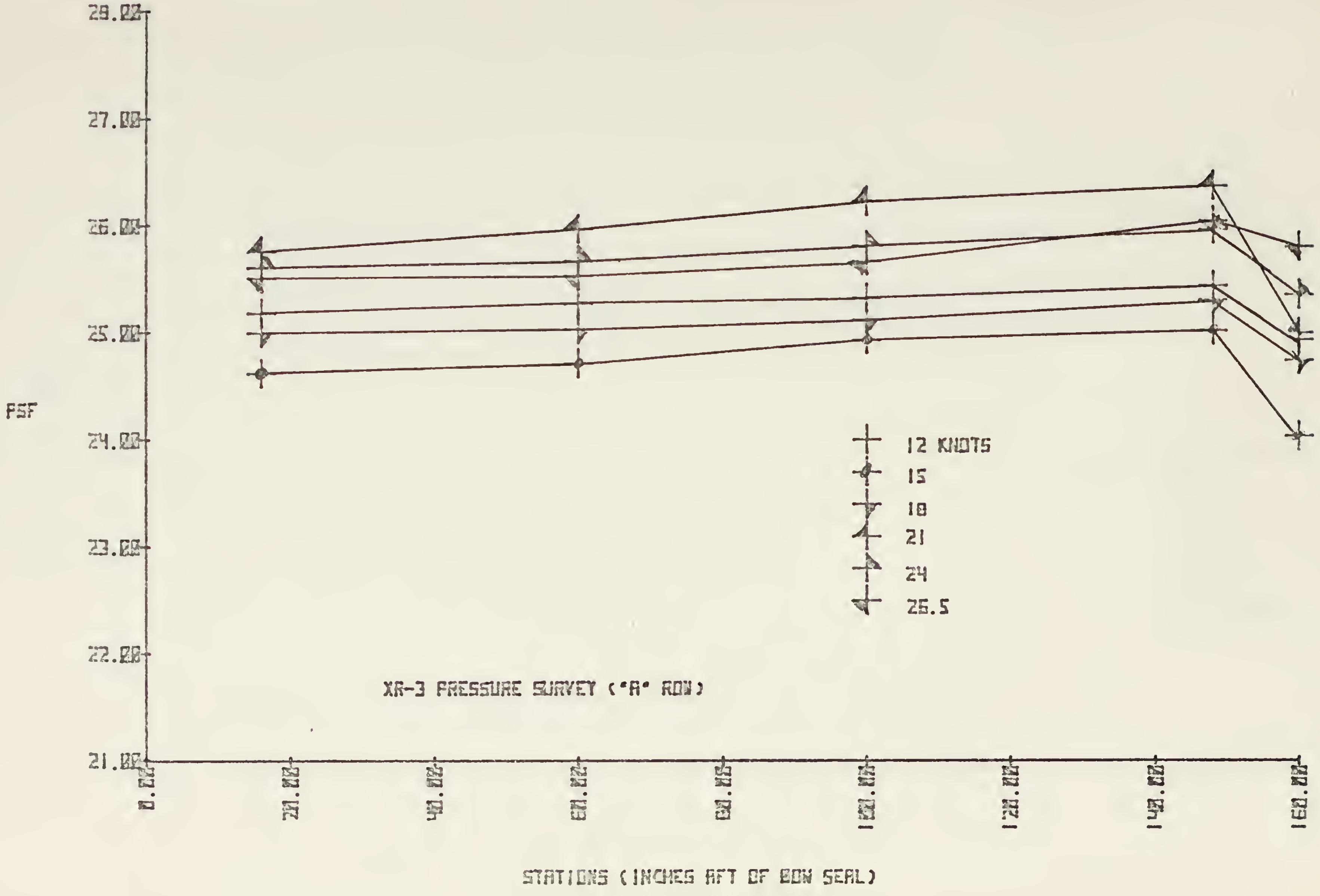
PSF
28.00
27.00
26.00
25.00
24.00
23.00
22.00
21.00
0.00
20.00
40.00
60.00
80.00
100.00
120.00
140.00
160.00
12 KNOTS
15
18
21
24
25.5
XR-3 PRESSURE SURVEY ("A" ROW)
STATIONS (INCHES AFT OF BOW SEAL)

FIGURE (8)

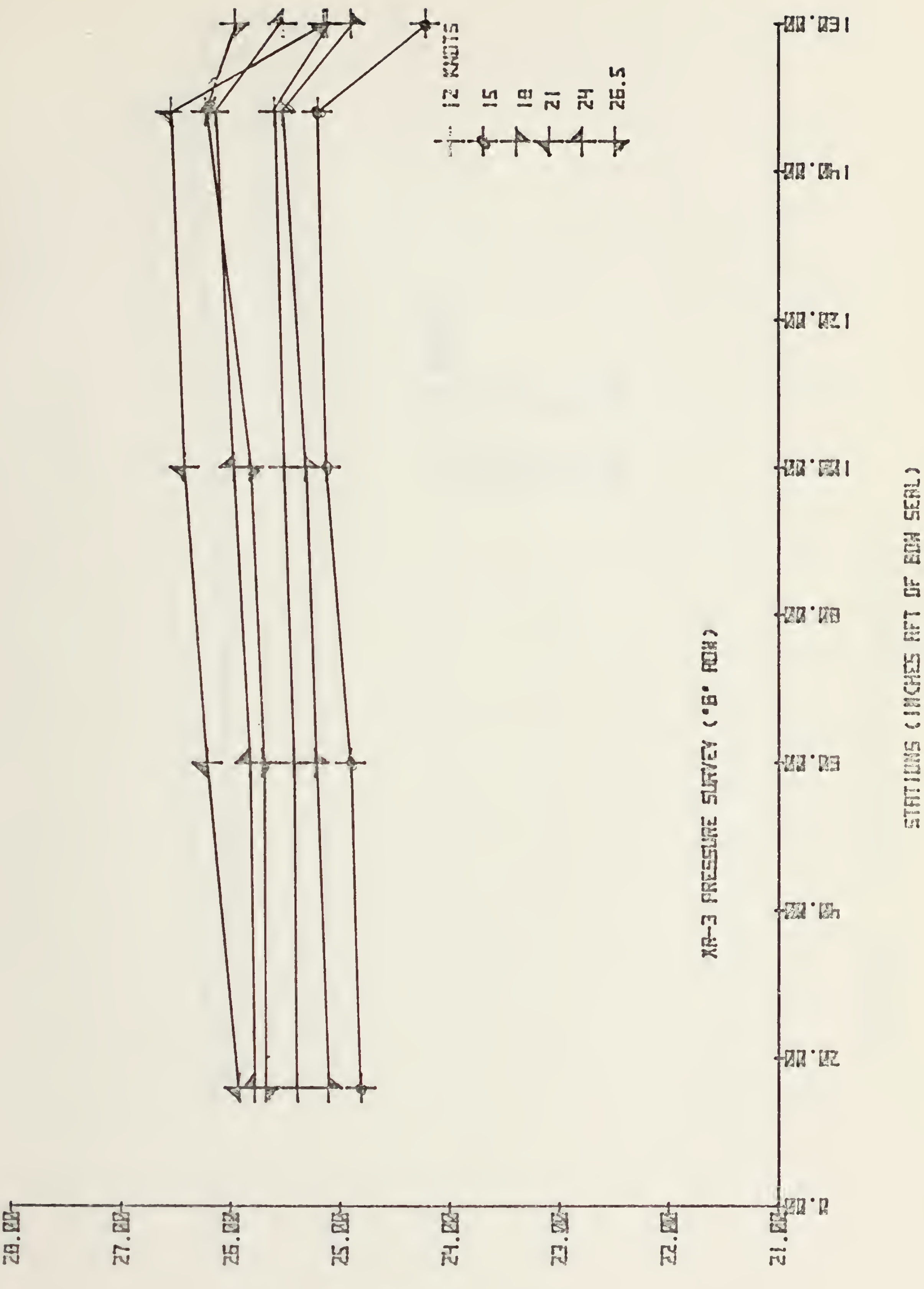
XR-3 PRESSURE SURVEY ('B' ROW)
PSF
28.00
27.00
26.00
25.00
24.00
23.00
22.00
21.00
0.00
20.00
40.00
60.00
80.00
100.00
120.00
140.00
160.00
STATIONS (INCHES AFT OF BOW SEAL)
12 KNOTS
15
18
21
24
26.5

FIGURE (9)

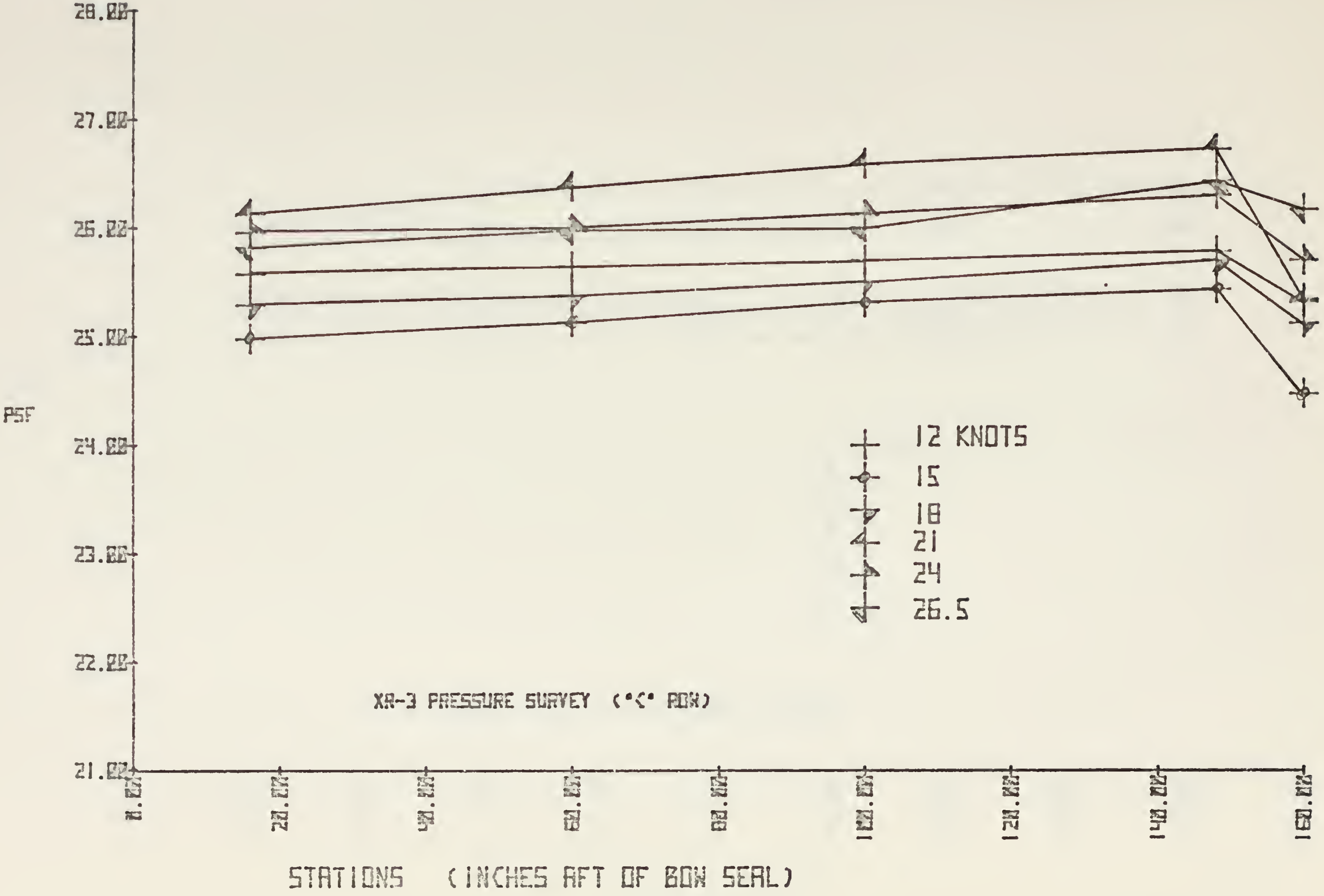
28.00
27.00
26.00
25.00
24.00
23.00
22.00
21.00
PSF
0.00
20.00
40.00
60.00
80.00
100.00
120.00
140.00
160.00
STATIONS (INCHES AFT OF BOW SEAL)
12 KNOTS
15
18
21
24
26.5
XA-3 PRESSURE SURVEY ("C" ROW)

FIGURE (10)

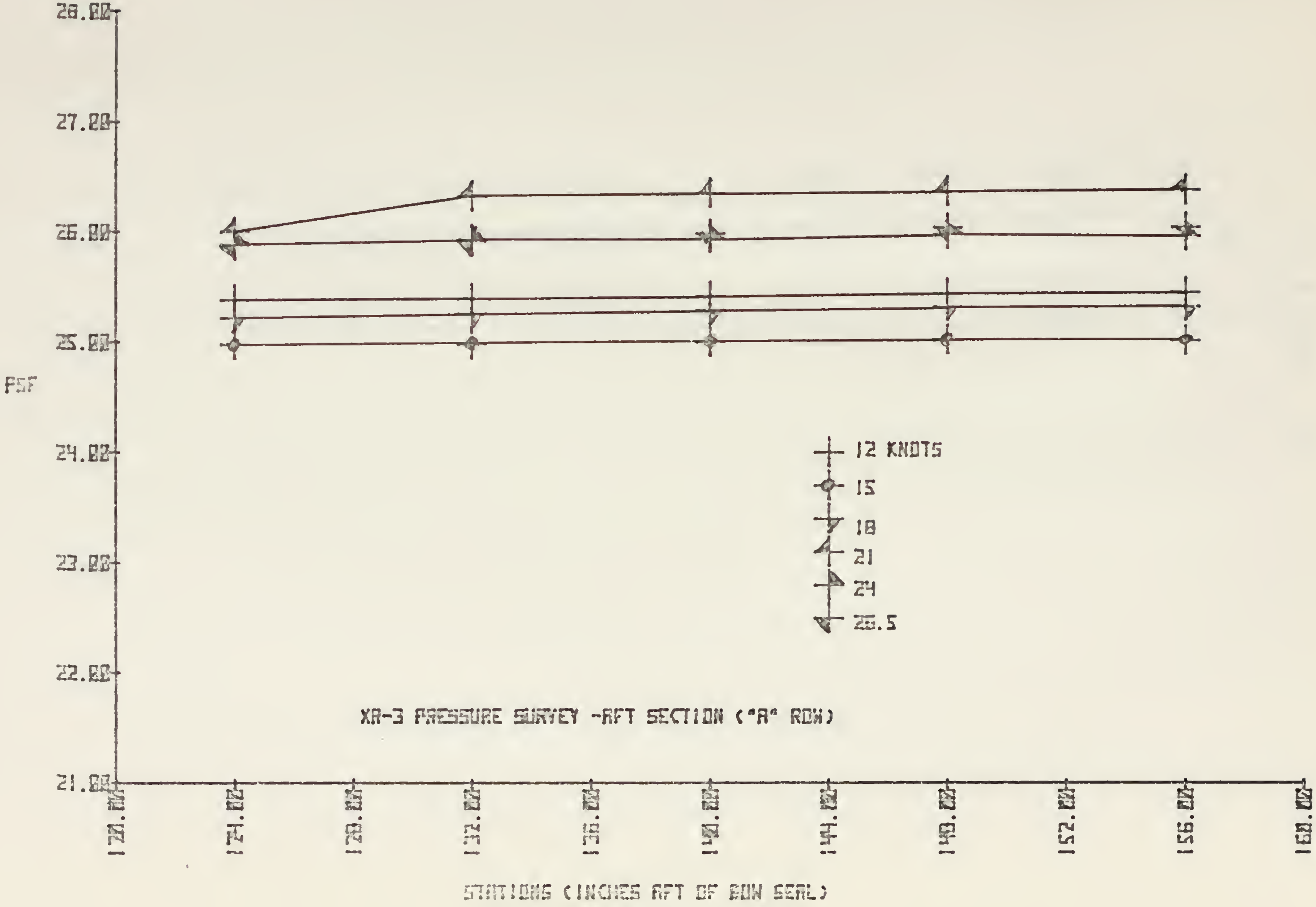28.00
27.00
26.00
25.00
24.00
23.00
22.00
21.00
PSF
12 KNOTS
15
18
21
24
26.5
XR-3 PRESSURE SURVEY -AFT SECTION ("A" ROW)
120.00
124.00
128.00
132.00
136.00
140.00
144.00
148.00
152.00
156.00
160.00
STATIONS (INCHES AFT OF BOW SEAL)

FIGURE (11)

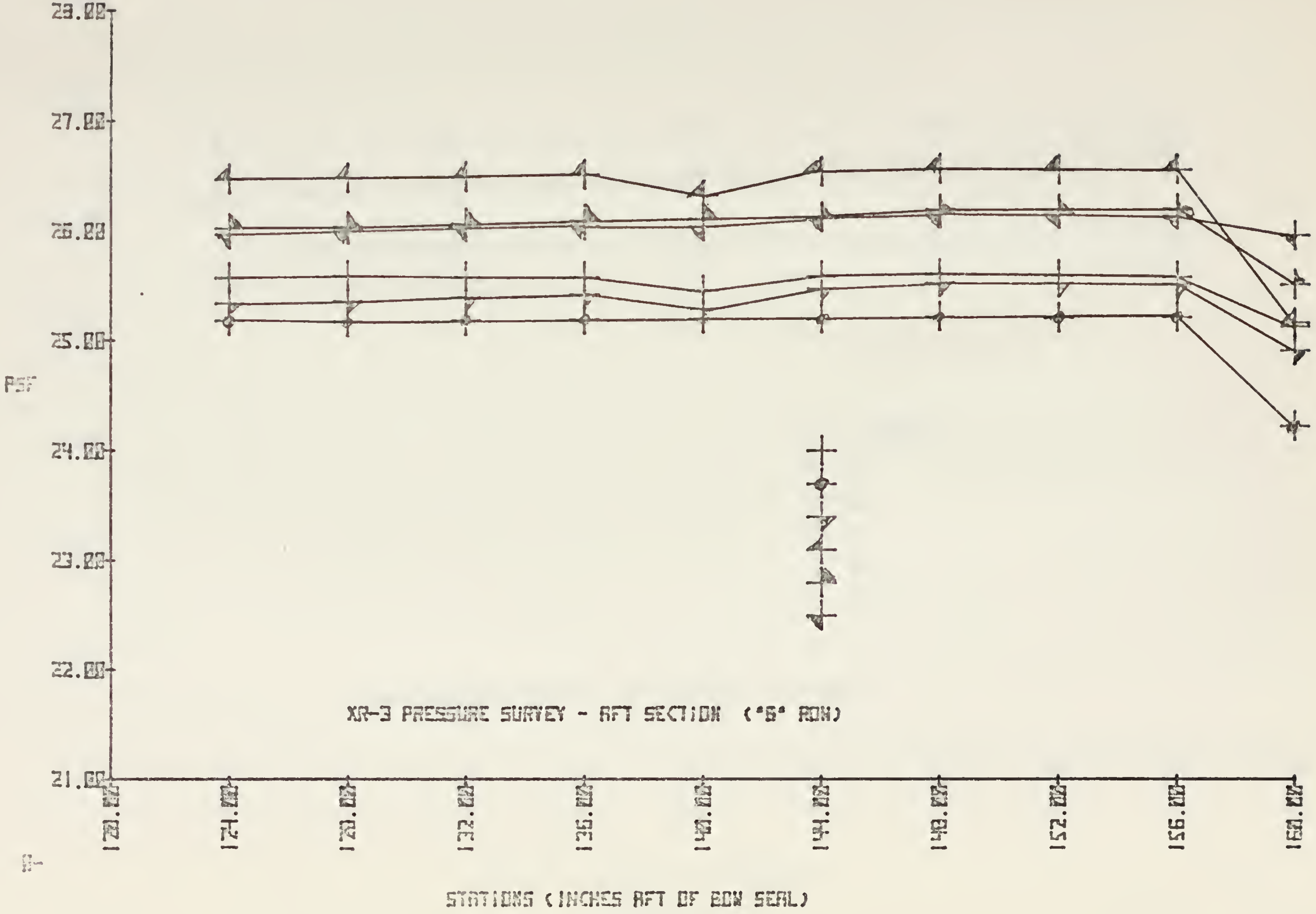
28.00
27.00
26.00
25.00
24.00
23.00
22.00
21.00
PSF
XR-3 PRESSURE SURVEY - AFT SECTION ('B' ROW)
120.00
124.00
128.00
132.00
136.00
140.00
144.00
148.00
152.00
156.00
160.00
STATIONS (INCHES AFT OF BOW SEAL)

FIGURE (12)

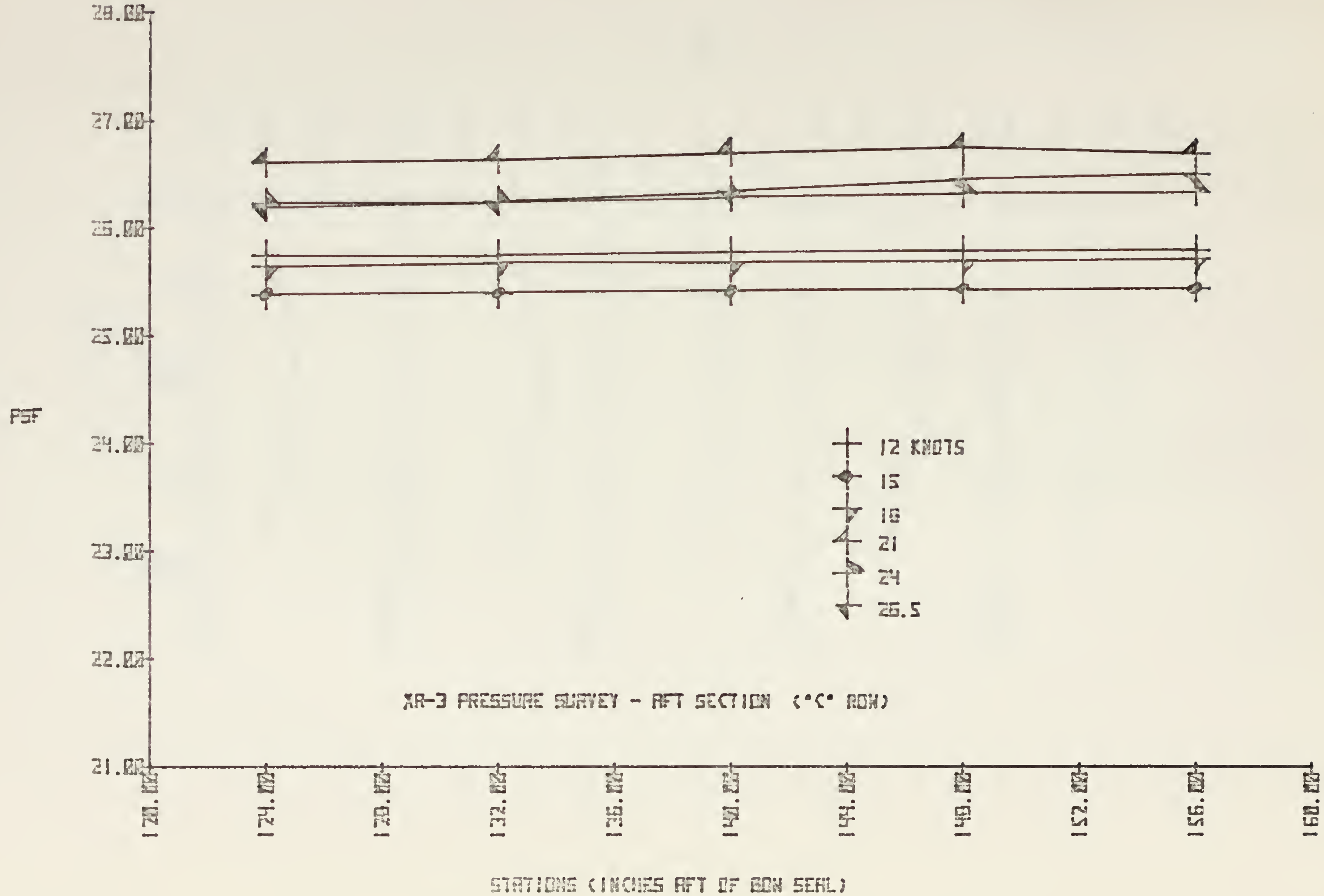
XR-3 PRESSURE SURVEY - AFT SECTION ("C" ROW)
PSF
28.00
27.00
26.00
25.00
24.00
23.00
22.00
21.00
120.00
124.00
128.00
132.00
136.00
140.00
144.00
148.00
152.00
156.00
160.00
STATIONS (INCHES AFT OF BOW SEAL)
12 KNOTS
15
18
21
24
26.5

FIGURE (13)

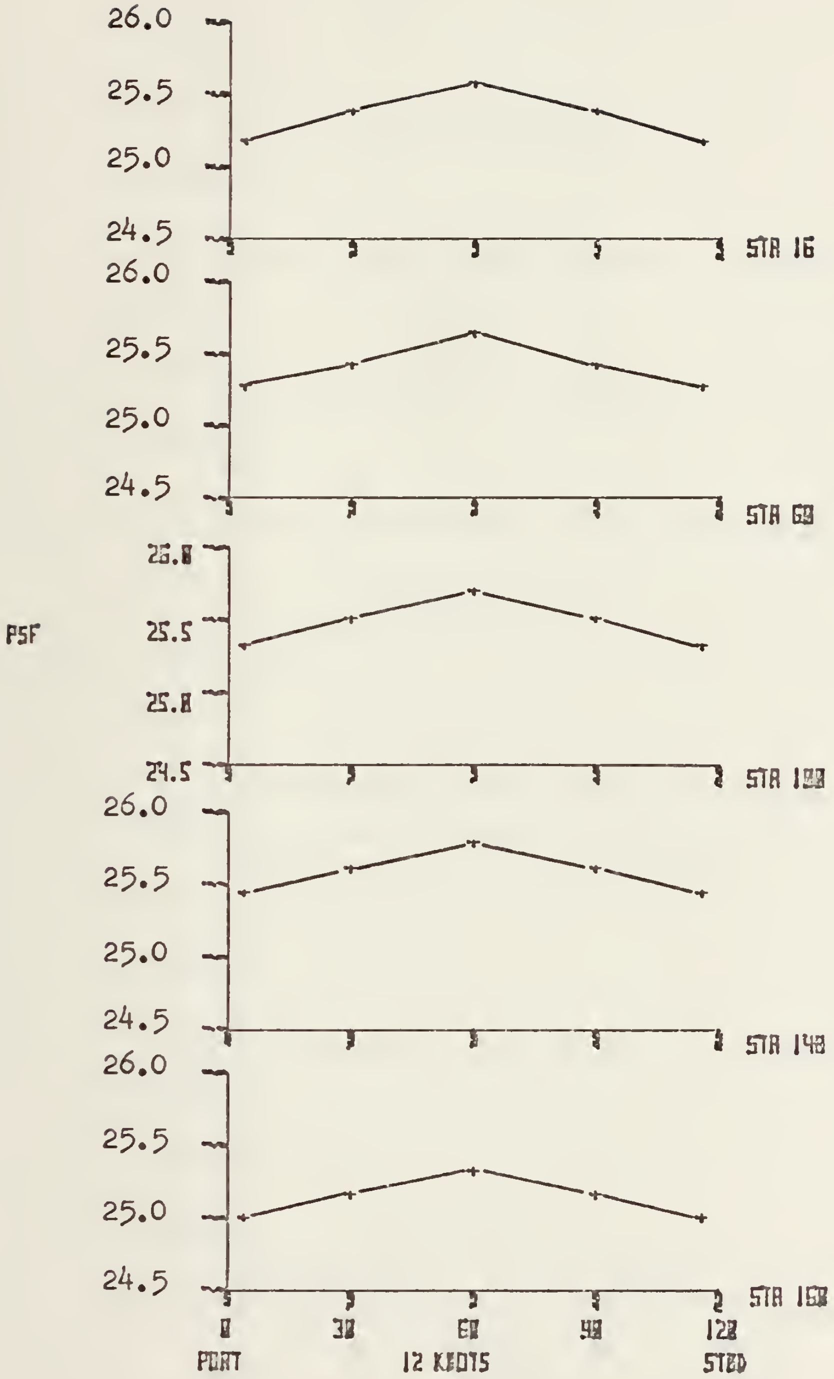
26.0
25.5
25.0
24.5
STA 16
26.0
25.5
25.0
24.5
STA 60
PSF
26.0
25.5
25.0
24.5
STA 100
26.0
25.5
25.0
24.5
STA 140
26.0
25.5
25.0
24.5
STA 150
0
30
60
90
120
PORT
12 KNOTS
STBD

FIGURE (14)

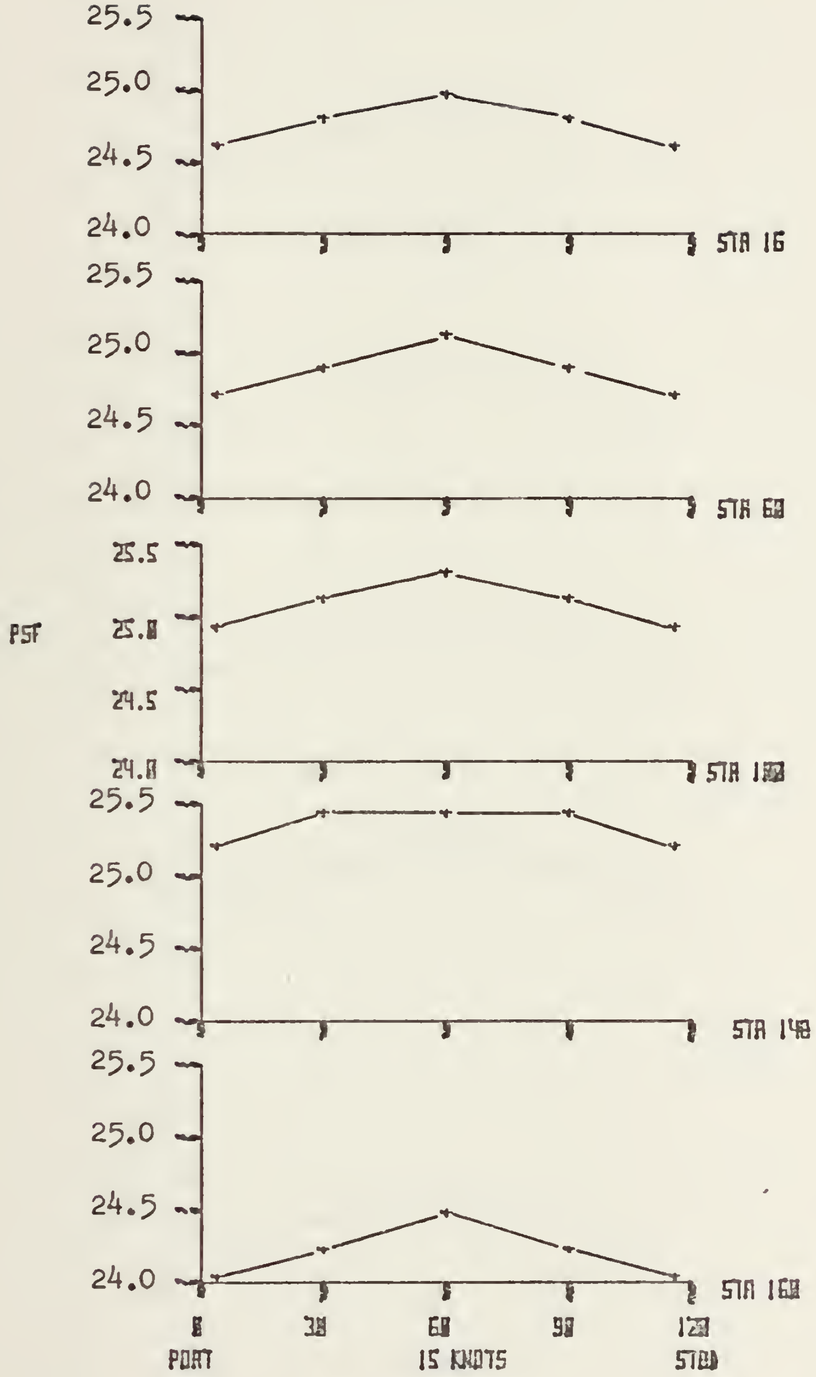
25.5
25.0
24.5
24.0
STA 16
25.5
25.0
24.5
24.0
STA 60
PSF
25.5
25.0
24.5
24.0
STA 100
25.5
25.0
24.5
24.0
STA 140
25.5
25.0
24.5
24.0
STA 160
0
PORT
30
60
15 KNOTS
90
120
STBD

FIGURE (15)

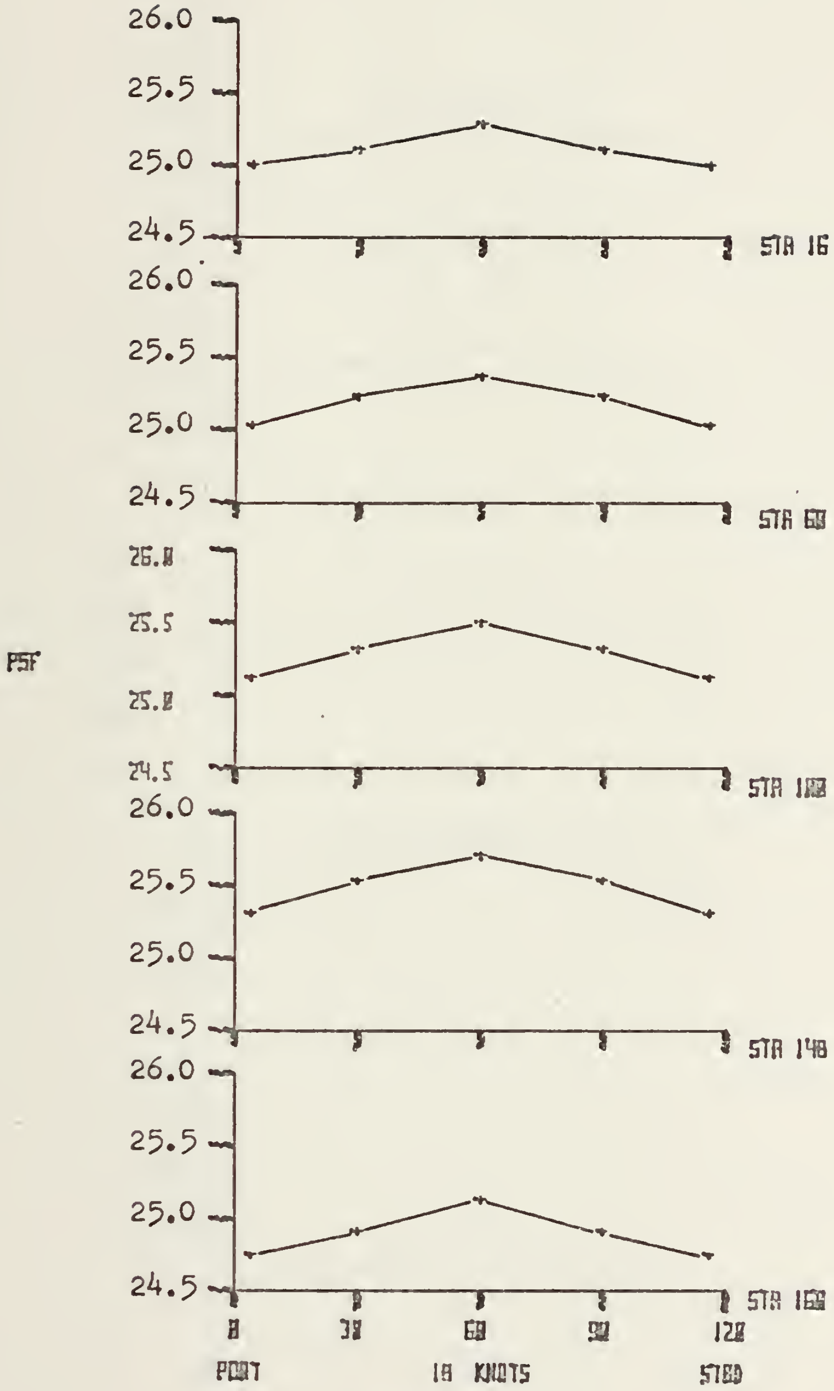
26.0
25.5
25.0
24.5
STA 16
26.0
25.5
25.0
24.5
STA 60
26.0
25.5
25.0
24.5
STA 100
PSF
26.0
25.5
25.0
24.5
STA 140
26.0
25.5
25.0
24.5
STA 160
0
30
60
90
120
PORT
10 KNOTS
STBD

FIGURE (16)

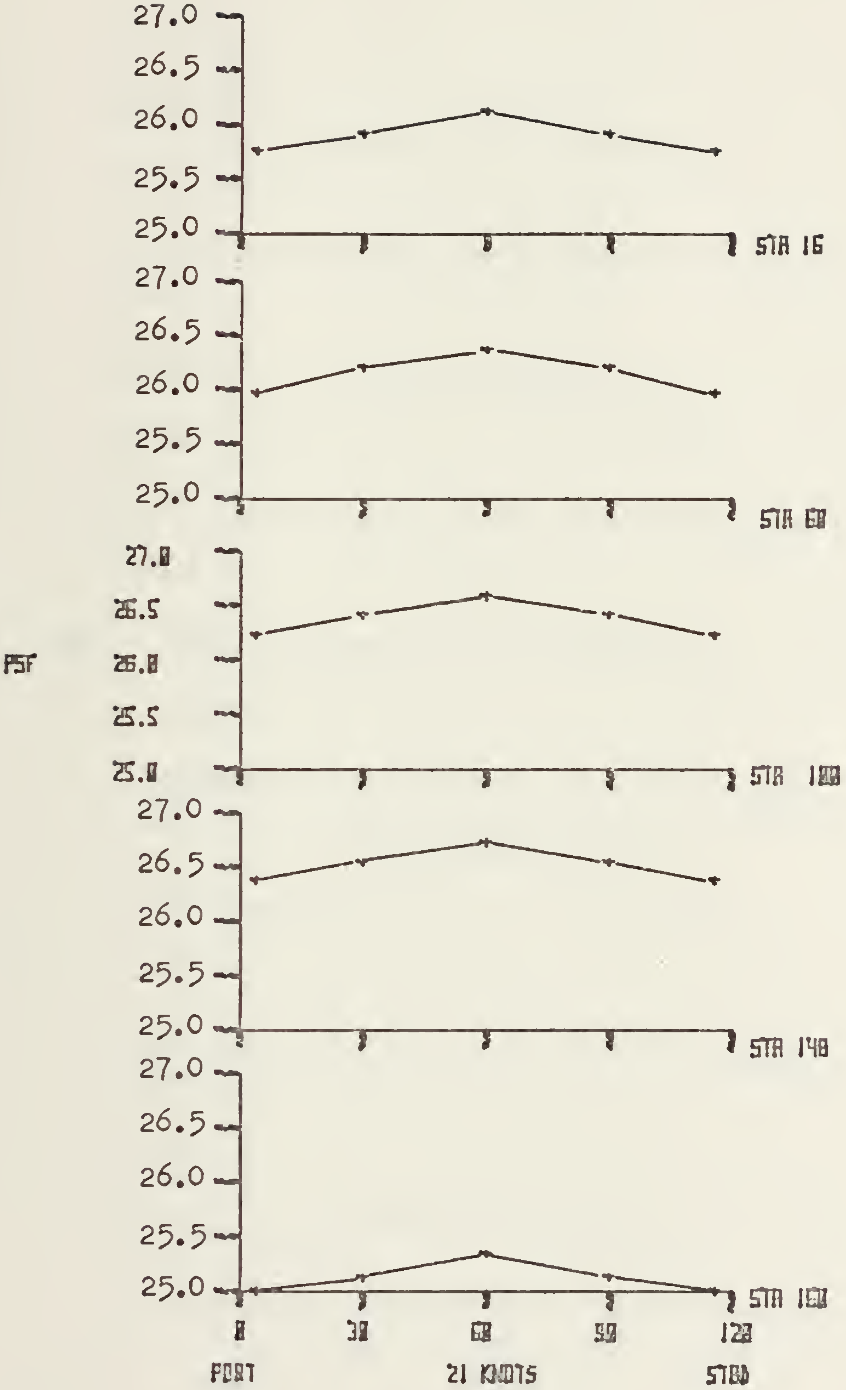
27.0
26.5
26.0
25.5
25.0
STA 16
27.0
26.5
26.0
25.5
25.0
STA 60
27.0
26.5
PSF
26.0
25.5
25.0
STA 100
27.0
26.5
26.0
25.5
25.0
STA 140
27.0
26.5
26.0
25.5
25.0
STA 180
0
30
60
90
120
PORT
21 KNOTS
STBD

FIGURE (17)

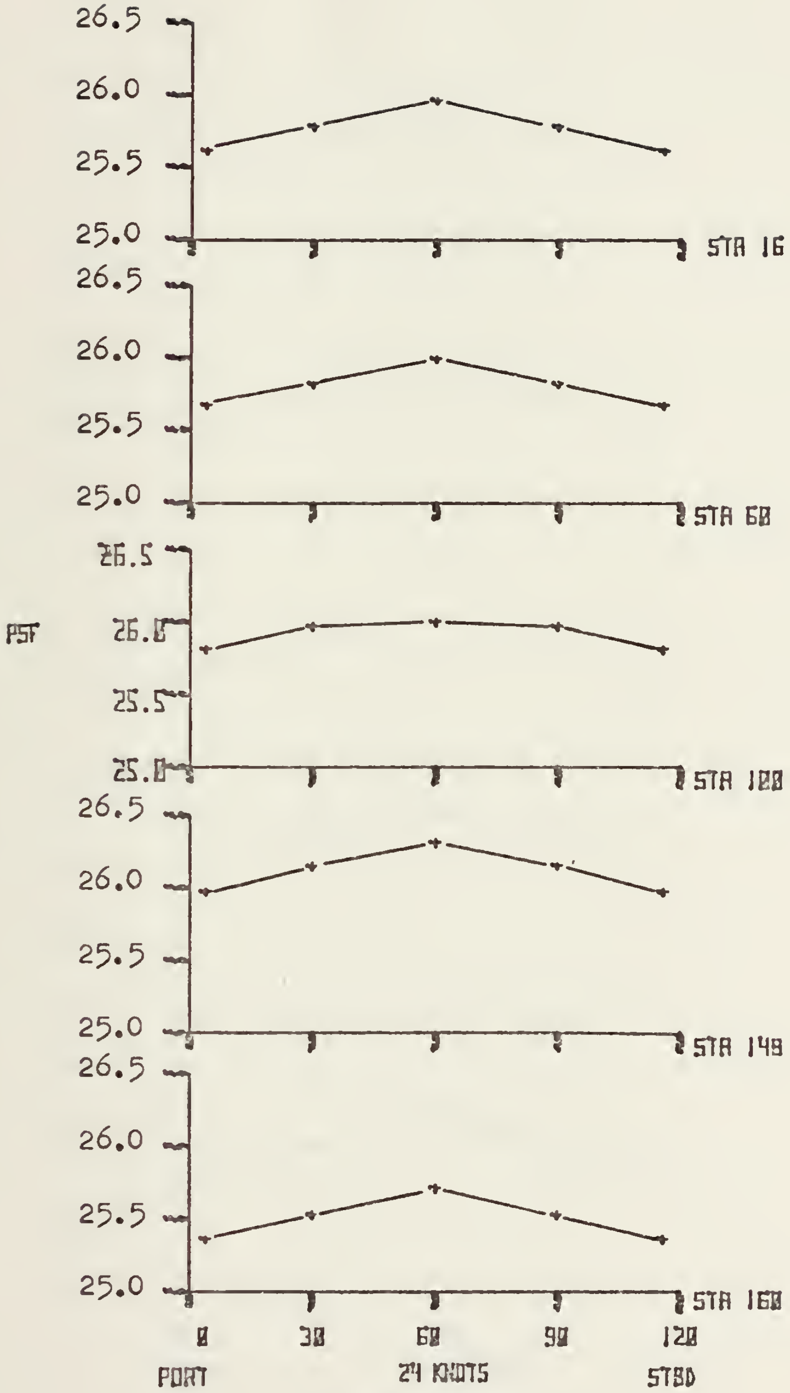
26.5
26.0
25.5
25.0
STA 16
STA 60
STA 100
STA 140
STA 160
PSF
0
30
60
90
120
PORT
24 KNOTS
STBD

FIGURE (12)

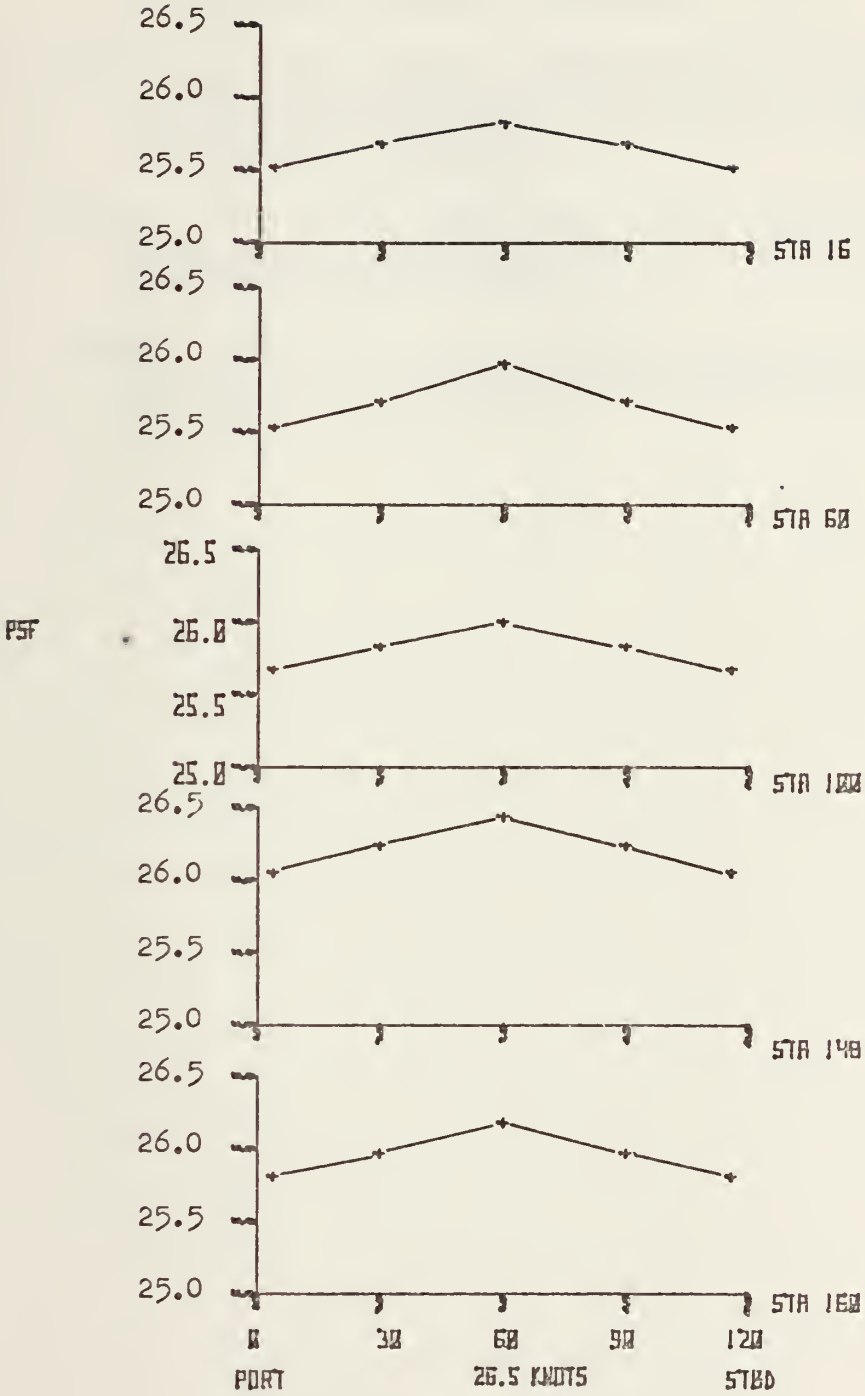
26.5
26.0
25.5
25.0
STA 16
26.5
26.0
25.5
25.0
STA 60
26.5
26.0
25.5
25.0
STA 100
PSF
26.5
26.0
25.5
25.0
STA 140
26.5
26.0
25.5
25.0
STA 180
0
30
60
90
120
PORT
26.5 KNOTS
STBD

FIGURE (10)

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